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STUDY ON THE DISPERSION PATTERN OF SOYBEAN LEAF BEETLE (*Paedonia inclusa* Stal.) POPULATION

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ABSTRACT

Subagja, J. 1996. Study on the dispersion pattern of soybean leaf beetle (*Phaedonia inclusa* Stal.) population. *Biologi* 2(2): 73—84.

The dispersion pattern of soybean leaf beetle (*Phaedonia inclusa* Stal.) was analyzed by the use of Iwao's method. Basically larvae, imagoes, and egg's colonies were contagiously distributed. They clumped in an area equal to one plant. Intra colony distribution was random. At high density, the distribution was more compact, with intra colony distribution was also aggregated. At lower density, the distribution loosened, with clump area equal to a quadrat size of eight plants.

Key words: dispersion pattern, soybean leaf beetle, ***Phaedonia inclusa***.

INTISARI

Subagja, J. 1996. Kajian pola pencaran populasi kumbang daun kedelai (*Phaedonia inclusa* Stal.). *Biologi* 2(2): 73—84.

Pola pencaran populasi kumbang daun kedelai (*Phaedonia inclusa* Stal.) dianalisis dengan metode Iwao. Pada dasarnya, larva, imago, dan koloni telur mengelompok. Kelompokan mereka menempati area kuadrat seluas satu tanaman. Penyebaran di dalam kelompok adalah acak. Pada kerapatan populasi tinggi, agihan mereka makin padat, agihan di dalam kelompok juga mengelompok. Pada kerapatan populasi rendah, agihan mereka menjadi longgar, dan masing-masing kelompok mempunyai area kuadrat seluas delapan tanaman.

Kata kunci: pola pencaran, kumbang daun kedelai, ***Phaedonia inclusa***.

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INTRODUCTION

Basically individuals in a population will occupy a certain position at their habitat. The positions of the individuals in the environment will disperse according to a certain pattern known as the dispersion (spatial) pattern of the population. The dispersion pattern is determined by size, distance, and position of clumps, and also position of indviduals in their respective clump. Inevitably the dispersion pattern depends on the biology of the species and the history of the population (Poole, 1974; Elliott, 1977).

The property of population distribution in a habitat is very important in selecting method for studying the population. Generally parametric test is used in population analysis with an assumption that the data follow a normal distribution. In fact, population distribution in nature is generally agregated (Odum, 1971), therefore the sampling data will not follow a normal distribution. This has been clearly stated by Southwood (1978) that the dispersion pattern will not only affect the sampling procedure and data analysis, but determines the shape and size of the sampling unit as well.

Study on the population dispersion will absolutely needed if sequential sampling method should be applied. The sequential sampling is an effective method in taking decision whether an action should be taken or not for controlling pest (Takeda, 1979; Shepard, 1980).

It has been known that the dispersion pattern often changes following the changes of population density. If the density is low, the dispersion pattern tends to follow a Poisson distribution, or random. However, at high density, the dispersion tends to be contagious or follows a negative binomial distribution (Iwao, 1972; Ruessink & Kogan, 1975; Southwood, 1978).

Soybean leave beetle (*Phaedonia inclusa* Stal.) is one of the important pests in soybean (Tengkano & Suhardjan, 1980). Susilo (1989) found an aggregated distribution in *P. inclusa* population. The last study was conducted by the use of an aggregation index formulated by Morisita (Morisita, 1962). Morisita's index devises a means of detecting clump area and also the spatial pattern of individuals within clumps. But still the method does not provide any information on the distribution pattern of clumps themselves (Iwao, 1972).

In this study, the dispersion pattern of *P. inclusa* is analyzed using methods introduced by Iwao in 1968 and 1972. By using the methods, the information on the dispersion pattern of clumps themselves of the insect population may be revealed. The information is often more desirable to know by ecologists (Iwao, 1972).

STUDY SITE AND METHODS

Study Site

The study was conducted in a soybean field located at Condongcatur, Sleman, Yogyakarta Province. The field consisted of ten blocks, each block with size of 8 X 16 m^2.

The soybean was of Orba variety, and planted with distance of 25 X 40 cm in March 1996. Urea and TSP fertilizers were applied to the field, and the doses were 50 kg/ha, and 75 kg/ha respectively. Population data were collected on on June 13, 21, and 28, 1996. At that time the vegetative growth of the plants were in the third and fourth stages. At those stages, the plants are susceptible to the attact of *P. inclusa*. Furthermore, at those stages the plants are large enough and their canopies were in contact with others. Such condition facilitates the insect to move freely from one plant to nearby plants.

Sampling Method

In each sampling, five blocks were selected randomly with relatively the same plants condition. In each block was located a large quadrat plot which consisted of six rows, and six coloms, each row and colom consisted of six plants. Therefore, the large quadrat plot provided 36 small quadrat plots, and each small quadrat plot equal to one plant.

In each plant, population of larvae, imagoes, and egg's colony were observed.

Method of Analysis

Data on the population were analyzed by Iwao's method (Iwao, 1968). Basically the method analyze the dispersion pattern by m^*-m relationship. m^* is the mean crowding, and m is the mean density of the population. The analysis used the small quadrat plot or one plant as the sample units. The relation of m^*-m is expressed as a regression relation

$$m^* = \alpha' + \beta' m$$

The analysis were then continued by the regression relation of m^*-m and ρ -index with successive changes of quadrat sizes (unit-size relation). According to the method, the successive changes of quadrat size should be u, $2u$, $4u$, $8u$, $16u$, etc.(Iwao, 1972). In this study, the successive changes of quadrat sizes were 1 , 2, 4, 8, 16, and 32 plants respectively. The regression relation of m^*-m with successive changes of quadrat sizes is expressed as

$$m^* = \alpha + \beta m.$$

RESULTS

The observations found that the population density of the larvae on 13 June 1996 was 3.74 larvae per plant, and then decreased with the densities of 1.68, and .47 on 21 and 28 June 1996 respectively. While the population of imagoes increased, with the densities of 1.53, 1.83, and 2.81 per plant. On June 13, 1996, there were 1.21 egg's colonies per plant (Table 1). On 21 and 28 June 1996 there were only one or two plants with one colony of eggs found, therefore the data were not able to be analyzed.

Results of the analysis on the regression relation of m^*-m with unchanges quadrat size (Iwao, 1968) found the values of α' and β' as shown in Table 1.

Values of α' for larvae, imagoes, and egg's colonies were always positive. This means that there were positive interaction between individuals in the populations.

Larvae population had values of $\alpha' > 0$ and $\beta' = 1$. Therefore the larvae had an overdispersed distribution, and randomly distributed colonies (clumps). Changes in population density tended to change the values of α' and β'. At low density, the values of α' and β' decreased to almost zero, as found on June 28, 1996. On the date, the larvae tended to have an underdispersed distribution, and uniformly distributed colonies (mean density is less than 1).

Populations of imagoes on June 13 and 21, showed that they had overdispersed distribution with randomly distributed colonies ($\alpha' > 0$; $\beta' = 1$) as in larvae on the same dates. The data indicated that the density of the population tended to increase, and this was followed by the decrease of both α' and β'. Therefore, on June 28 the population density was high and tended to be more aggregated, and their clumps contagiously distributed ($\alpha' > 0$ and $\beta' > 0$) (Table 1).

Table 1. α' and β' of the m^*-m regression relation analysis and population densities per plant

Observation	Population	α'	β'	Density
June 13, 1996	Larvae	3.64	.93	3.74
	Imagoes	.53	1.01	1.53
	Eggs	1.62	1.15	1.21*
June 21, 1996	Larvae	.53	1.02	1.68
	Imagoes	.76	1.00	1.83
June 28, 1996	Larvae	.01	-.01	.47
	Imagoes	.84	.15	2.81

Note: * : 1.21 egg's colonies per plant.

Data on the population of egg's colonies were not conclusive. Indeed the population had an overdispersed distribution, but since $\beta' = 1.15$ (far enough from 1) the distribution of the clumps could not be concluded.

Results of the analysis by the use of m^*-m regression relation and ρ-index with successive changes of quadrat sizes were figured out in Figures 1-3. α and β of the regression relations were summarized in Table 2.

Basically the results of the last analysis did not show significant different with the first analysis. However, the results gave more information on the dispersion of the clumps themselves.

Populations of the larvae on June 13 and 21 had the same distribution. The intra colony distributions were random, this means that individuals in each clumps were randomly distributed. The area occupied by the clump was egual to the smallest quadrat size (one plant) or they clumped in one plant (Figure 1 & Table 2). On June 28, as the density was low enough, the colonies uniformly distributed.

Table 2. Values of α and β of the m^*-m regression relations with changes of quadrat sizes

Observation	Population	α'	β'
June 13, 1996	Larvae	5.57	.96
	Imagoes	2.11	.96
	Eggs*	3.54	1.02
		12.98	.64
June 21, 1996	Larvae	1.05	.99
	Imagoes	.67	.99
June 28, 1996	Larvae	.63	.94
	Imagoes	3.80	1.02

Note : * : The actual regression relation is not linear.

The intra colony distribution was also uniform (Figure 1; Table 2). The area occupied by a clump was equal to eight plants, since they were underdispersed (Figure 1B3).

Population of imagoes on 13 and June 28, 1996 had the same distribution pattern as shown by larvae populations on the same dates. On June 28, as the density increased, the aggregation was more compact. The intra colony distribution was also aggregated, and the clump occupied an area equal to one plant (Figure 2; Table 2).

For egg's colonies, the analysis showed that m^*-m relation with successive changes quadrat sizes was not linear. The results of the analysis might be interpretated that the colonies of eggs were aggregated, and the clumps were uniformly distributed (Figure 3; Table 2). The area occupied by a clump of egg's colonies was equal to eight plants (Figure 3B).

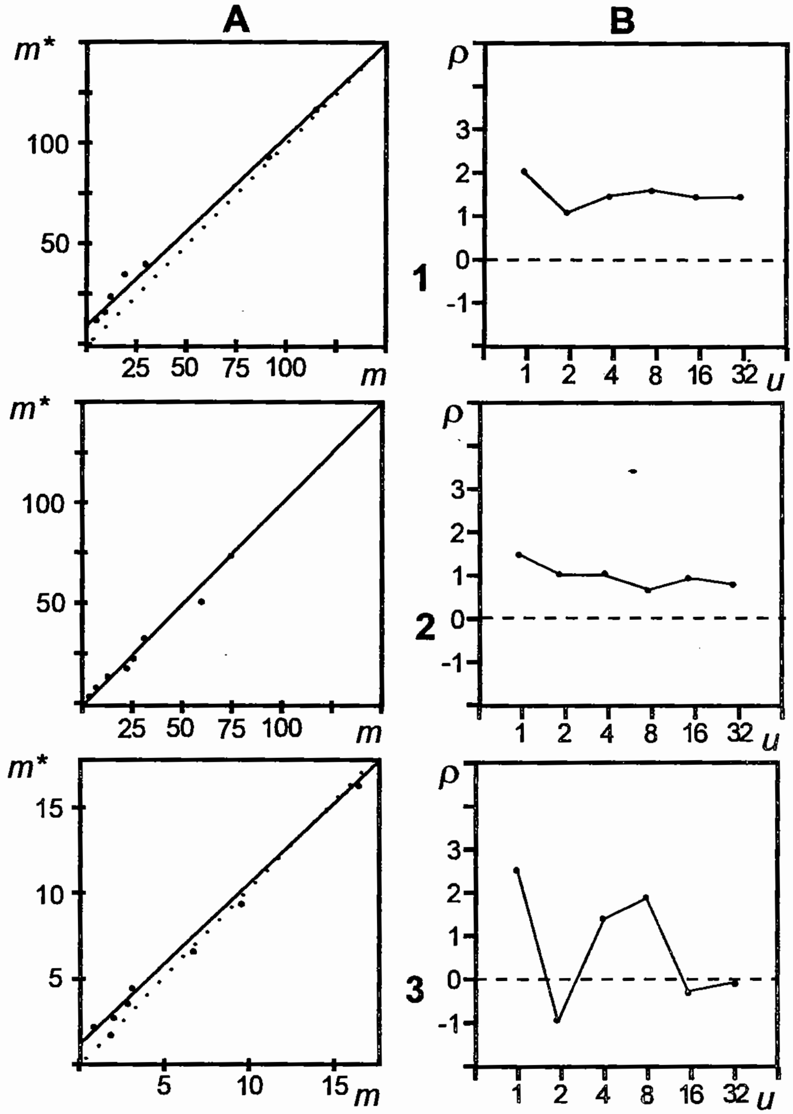

Figure 1. Results of analysis on population of larvae

A: m^*-m regression relation with successive changes of quadrat size.
B: ρ-index plotted againts quadrat size (u).
1: Population on June 13, 1996.
2: Population on June 21, 1996.
3: Population on June 28, 1996.

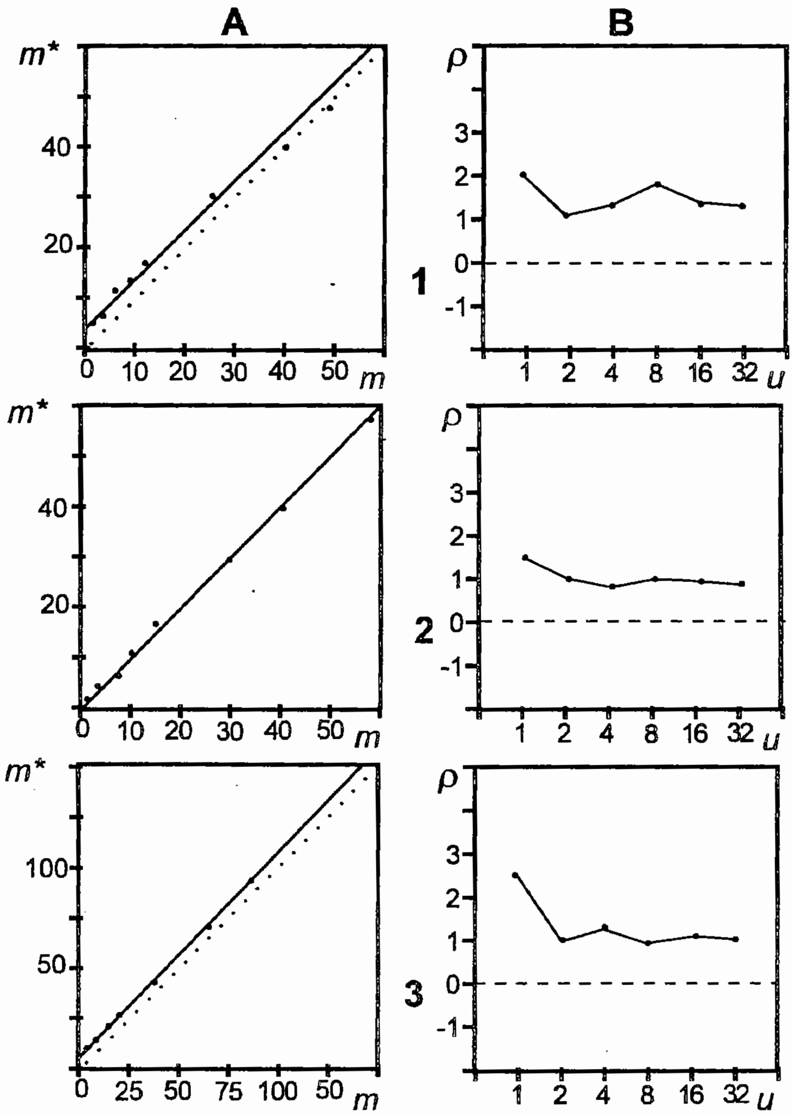

Figure 2. Results of analysis on population of imagoes

A: m^*-m regression relation with successive changes of quadrat size.

B: ρ-index plotted againts quadrat size (u).

1: Population on June 13, 1996.

2: Population on June 21, 1996.

3: Population on June 28, 1996.

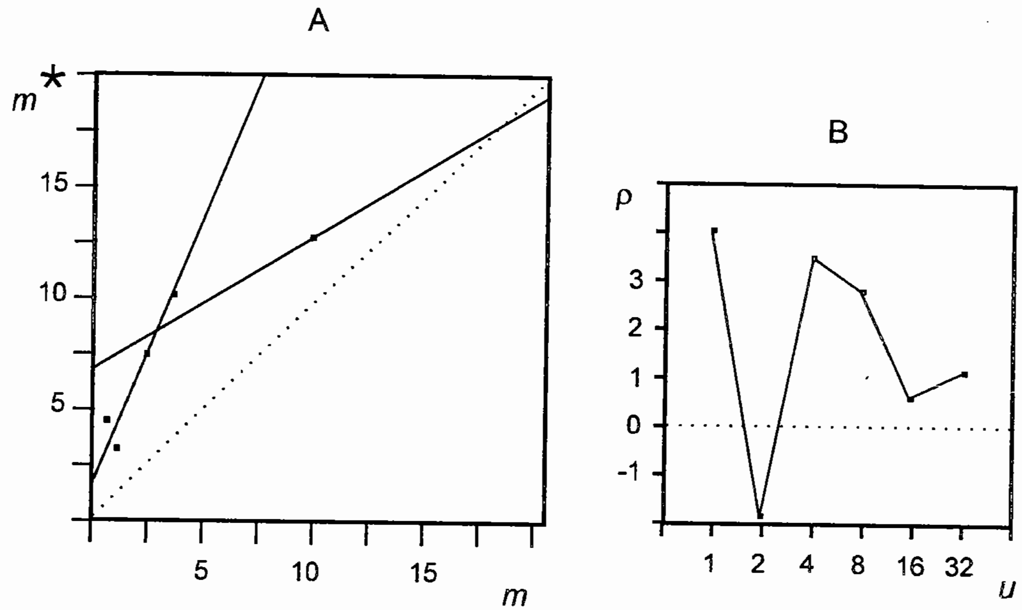

Figure 3. Results of analysis on population of egg's colonies.
A : m^*-m regression relation with successive changes of quadrat size.
B : ρ-index plotted againts quadrat size (u).

DISCUSSION

Changes of population density in *P. inclusa* is followed by the changes of the dispersion pattern. Such changes in dispersion pattern is commonly happened in natural population (Iwao, 1972; Ruesink & Kogan, 1975; Southwood, 1978). This study barely shows that at high density, populations of larvae and imagoes tends to be overdispersed or their clumps are more compact. At low densities they are underdispersed or loosen their clumps. This indicates that both individuals of larvae and imagoes tend to interact each other. When their densities are too low (less then 1 individual per plant), they are still aggregated although their clumps are too spacious as they occupy an area equal to eight plants. When their densities are more than 1,5 per plant, their clumps are more compact, and occupy an area equal to one plant only.

Dispersion pattern of eggs is affected by the dispersion of imagoes, since eggs are laid down by the imagoes in colonies at lower surface of leaf. Apparently, the mobility of the larvae is low, and this causes their dispersion is more or less affected by the dispersion of eggs. Unfortunately, this study could not completely analized the dispersion pattern of egg's colonies at different densities. On June 13, the density of egg's colonies was only 1.21 colonies per plant (Table 1), and this was not a high density. Therefore, they were loosely dispersed, and the area of thier clumps were equal to eight plants. Considering the dispersion pattern of larvae and imagoes, it was apparent that eggs population on June 13 was at low density, and they had higher density before the date.

Using Morisita's index, previous study found that the population of *P. inclusa* was aggregated. Rows of plants did not affect the dispersion pattern. But the dispersion was affected by blocks, since plant condition in the blocks were not similar (Susilo, 1989). This means that if plant conditions are similar, block will not affect the dispersion. The current study, blocks are randomly selected with the same plant condition, therefore blocks may not affect the dispersion.

Results of the analysis show that basically population of *P. inclusa* has an overdispersed dispersion. Larvae, imagoes, and egg's colonies clump in one plant only. Movement of individuals from one plant to another is very limited. Obviously, the mobility of *P. inclusa* is low, although the imagoes are able to fly, in fact they rarely fly (Kalshoven, 1981). Imagoes emerge from pupas in soil, move out to get a plant for their habitat, and then they settle in the plant. Implementing the results, one may easily use one plant as a unit sample in studying population of *P. inclusa* in soybean, and this is recommended.

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